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VIII.

ON THE PHOTOGRAPHIC ACTION OF DRY SILVER BROMIDE COLLODION, &c., TO RAYS OF SOLAR LIGHT OF DIFFERENT REFRANGIBILITY.

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Presented June 10th, 1877.

1. In continuation of experiments reported to the Academy in May, 1876, I present the following results: Further experiments demonstrate that silver bromide collodion is sensitive to all the visible rays of the spectrum, but requires a very prolonged exposure to the less refrangible rays. A gradual decrease of photographic action in reducing the silver salt is observed from about line F to line A, the latter being almost imperceptible, though by careful observation a very thin deposit of metallic silver can be made out at the red end.

2. Some of the glucosides, such as salicin, amygdalin, populin, and santonin, slightly increase the photographic action of the silver salt, when exposed to the less refrangible rays. This reduction of the silver salt does not occur as a selective action, — that is to say, in certain isolated portions of the spectrum; but the photographic image is somewhat stronger at F, and gradually fades out towards line A.

3. Stewart-Wortley dry plates, which contain salicin and uranium with the silver bromide, on exposure to the solar spectrum, show an increased action from F to A, and the image is stronger than when a glucoside alone is added to the silver bromide; but in these there is no selective action below line F.

4. Colonel Abney claims that the addition of benzoin and bromine to a collodion made at a high temperature increases the sensitiveness of a silver bromide dry plate to the less refrangible rays of the spectrum, and to some of the ultra red rays. Only one plate out of a large number prepared according to Colonel Abney's directions * bears in my hands any confirmation of his results. It should, however, be observed that the presence of benzoin and bromine in a sensitized collodion plate,

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* The details of the process were kindly sent by him to me.

on account of a more minute subdivision of the reduced silver, gives a better-defined and sharp image.

5. Silver bromide in gelatine (gelatino-bromide emulsion) shows much more action to all rays of the visible spectrum than when this salt is suspended in collodion: the strength of the image gradually diminishes from the blue to the red end, but gives no selective action below line F.

6. Some of the aniline dyes dissolved in a collodion sensitized with silver bromide containing an excess of silver nitrate and then dried, give in my hands very positive results, which, in detail, are as follows: It is well known that solar light passing through a solution of magenta red, fuchsin, water-blue, or œosin, all being aniline colors, shows selective absorption of certain rays of the solar spectrum. If a silver bromide collodion be faintly colored with œosin, for instance, then immersed in a strong bath of silver nitrate, so that there shall be over the surface of the collodion an excess of silver nitrate, which after immersion should be thoroughly washed off, and dried in the dark; then if this be exposed to the image of the spectrum in focus, a stronger image of the solar lines will be developed upon the collodion between E and D lines, the maximum of action being between these lines; and a faint image will be developed between the F and E lines. In other words, there is a selective photographic action in that portion of the spectrum (viz., between E and D) where the absorption band of the sunlight colored by this aniline dye is usually observed. Attention is specially called to the fact, that, if the pigment is added to the sensitized collodion after the excess of silver nitrate has been washed off, the effects above mentioned do not follow. We have taken advantage of this phenomenon to photograph quite distinct images of solar lines between F and B, which were refracted by two dense glass prisms* and projected by a common 40-in. spectacle lens. I exhibit these photographs to the Academy. I also exhibit the photographic image of the absorption bands of blood, of didymium nitrate and potassic permanganate in solution; likewise, a solution of grass chlorophyll. This latter substance offers unusual difficulties, from the fact that, in order to get chlorophyll absorption bands, the sunlight must be very strongly colored with chlorophyll, which circumstance allows an amount of light insufficient to effect the silver reduction, unless under a prolonged exposure. This plate was exposed one and a half hours;

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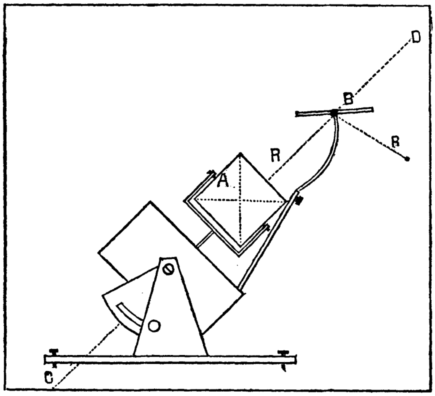
* These prisms were made by Adam Hilger of London, being duplicates of those he made for Colonel Abney for his photographic experiments.

consequently the image is somewhat blurred, both from forced development as well as from diffused light. The scientific value, then, of these phenomena consist in enabling us to photograph an image of that portion of the spectrum which comprises rays of less degree of refrangibility than line F, and especially those between lines E and C, and perhaps also at B. It is in this part of the spectrum that many natural colors absorb the rays of light. All these photographs of absorption bands exhibited to the Academy were taken by the dried silver bromide collodion colored by œosin and fuchsin.

We devised for these experiments a new form of heliostat, the beam of sunlight reflected from which varied so slightly that we were able to expose some of our plates for an hour and a half without any re-adjustment of the instrument. The cheap cost of this form of heliostat and its simple mechanism, compared with other instruments of equal accuracy, induce me to present its description to the Academy.



As will readily be seen, this instrument consists of a stand, equatorially mounted, and containing a small watch movement, in the train of which a wheel is connected, which revolves once in twenty-four hours. In the centre of this wheel a pinion is fixed, upon which a mirror can be adjusted and firmly set. When placed in its correct position, the reflection of a central beam of sunlight is thrown directly in a line C D parallel to the polar axis of the earth. An upright rod, carrying another silvered mirror B, intercepts at any angle to the first mirror this central beam of light, and reflects it in any desired position. In our experiments, the path of this beam is horizontal, and passes through a hole in a dark shutter upon the slit of the spectroscope. We used the reflection from the silver surface of the mirror, as affording us more light.

The advantages of this instrument lie in its simple construction and the ease of its accurate adjustment. The angle of declination in relation to the North star on that part of the earth in which the heliostat is to be used being found, the mirror A is adjusted to throw its central ray R of reflected sunlight upon the centre of the mirror B; consequently, as the mirror B is fixed in the axis of the instrument, the beam of light must necessarily travel along that axis, and the error caused by the motion of the earth is thus compensated as accurately as if the angle of declination were calculated upon the arc of the circle whose radius is equal to a line drawn from the centre of the surface of mirror A to that of mirror B.

In the course of my experiments, the following observation has been noted: —

It has generally been supposed that the human eye is not sensitive to that part of the solar spectrum which contains rays of a higher degree of refrangibility than H H. To show that this phenomenon is not constant, the following observation is offered: If the solar spectrum be projected by a converging lens, and received upon the retina of the eye at its proper visual focus, the *extra*-violet rays and their solar lines as far out as L are visibly distinct.

To make this phenomenon more apparent, let the image of the spectrum be received upon an opaque paper screen, and from which a hole has been cut out, so that only that portion of the spectrum between H and L may pass through and be received upon the retina of the eye. A little practice in receiving the image at its proper focus will produce the effect above alluded to.